USE OF NANO-K FERTILIZER AS A SOURCE OF POTASSIUM IN RICE CULTIVATION

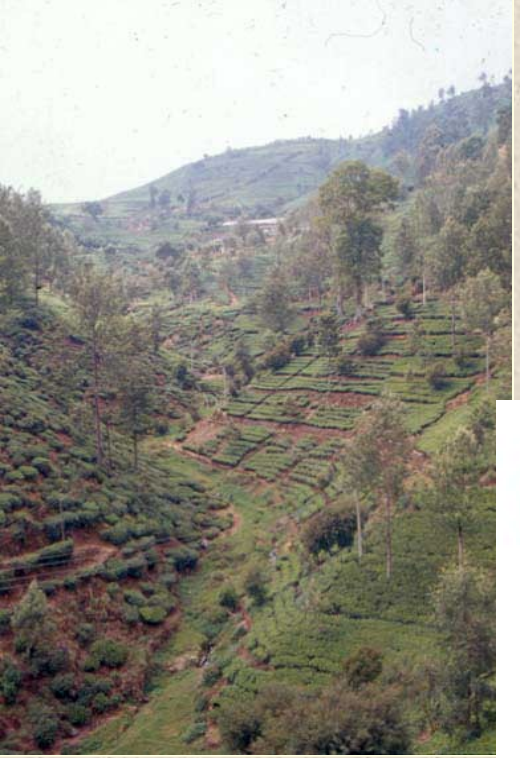
DN Sirisena and DMN Dissanayake
Rice Research and Development Institute
Batalagoda, Ibbagamuwa

V Karunaratne and N Kottegoda
Sri Lanka Institute of Nanotechnology
Walgama, Malwana

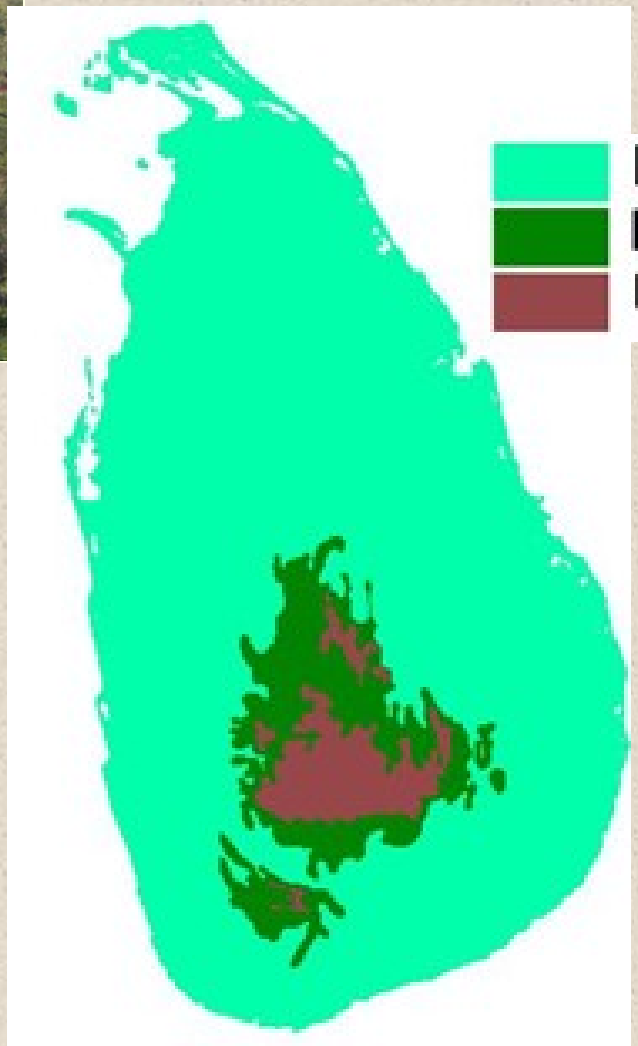
Rice: The most important food crop for Sri Lankans

- Per capita consumption
  - 110 - 116 kg / year
  - major source of energy (40%) and protein (40%).
- Area under rice
  - 0.8 million hectares
  - 18 % of the total agricultural land extent
- Rice growing seasons
  - Dry season: March - August (Yala)
  - Wet season: September - February (Maha)

Rice growing Land forms



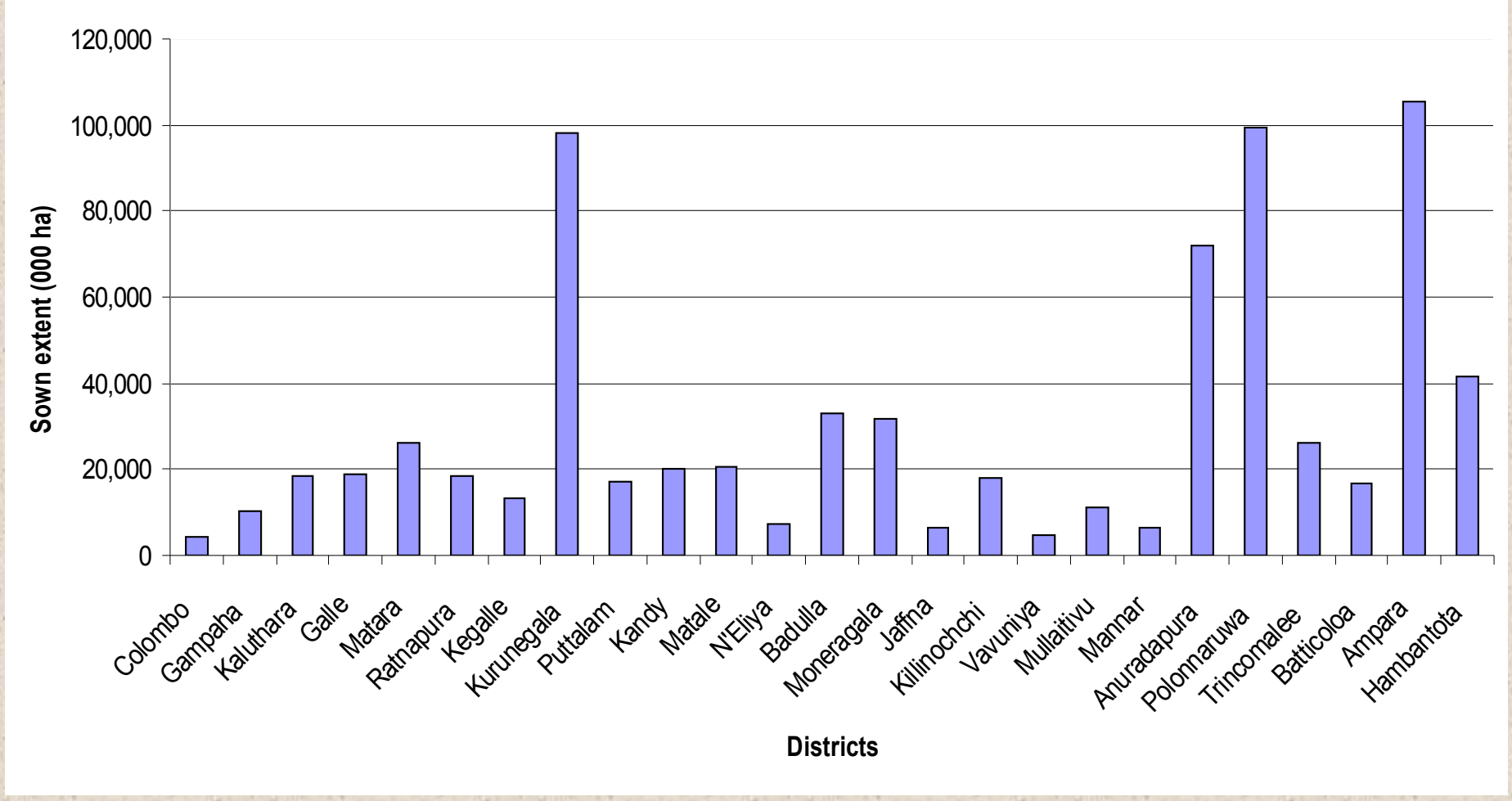
Up country
>1000 m



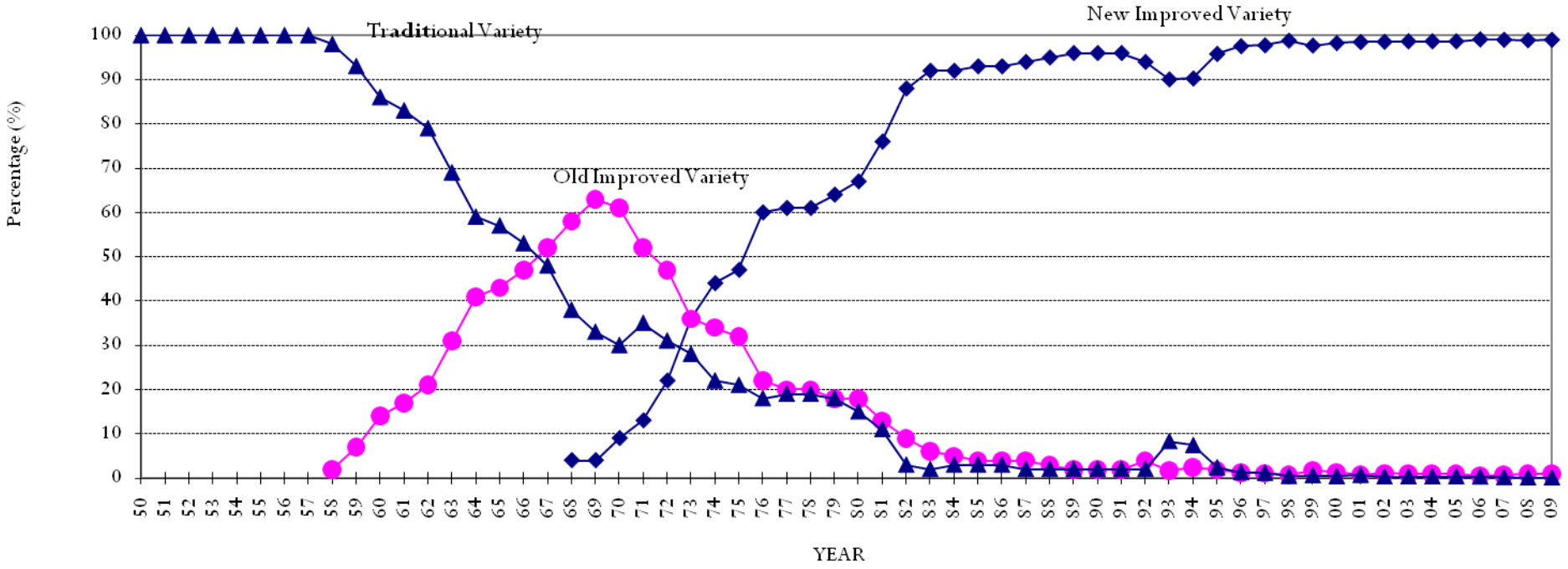
Mid country
300- 1000 m

Low country
< 300 m

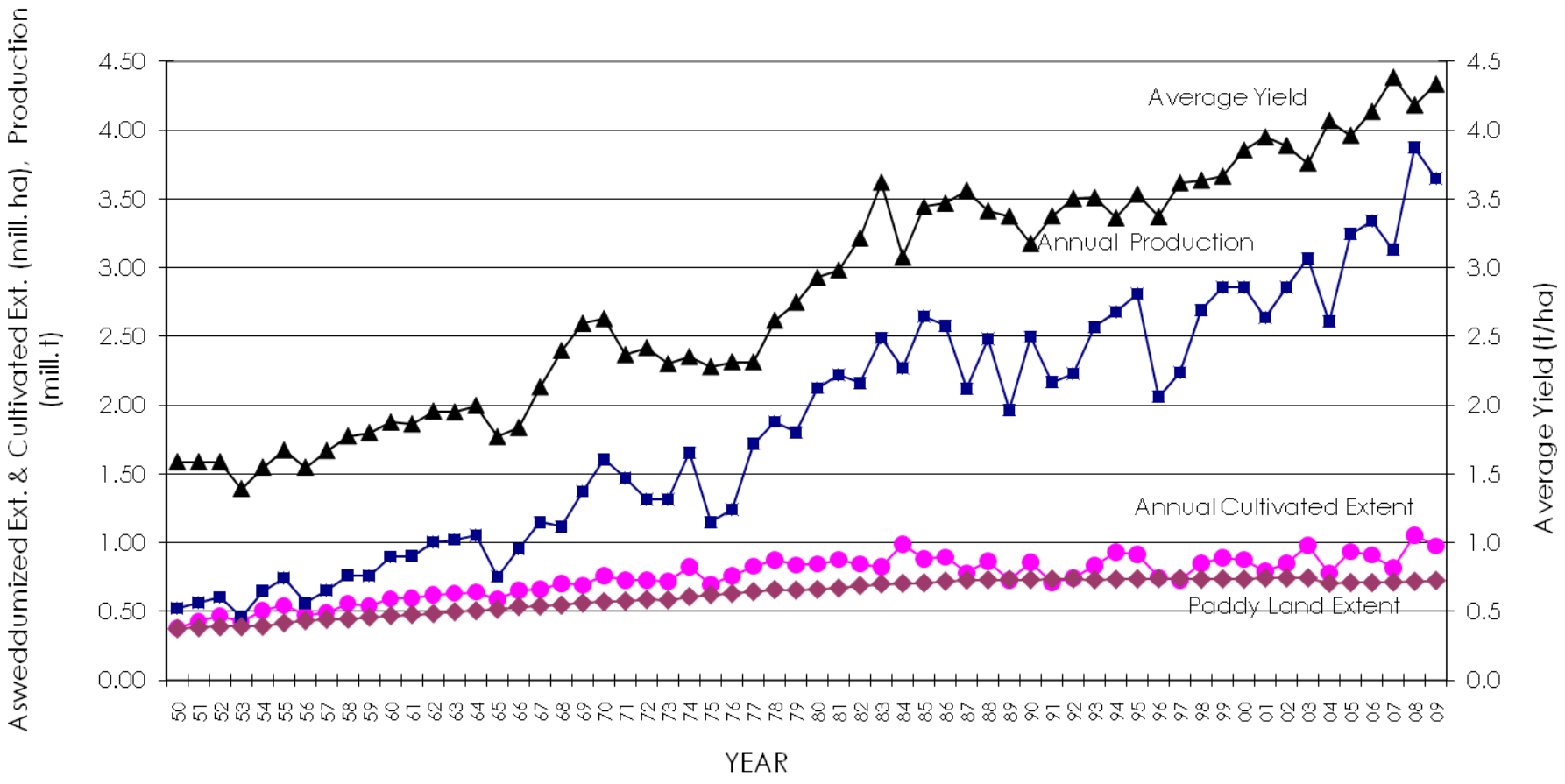
Rice cultivation in Sri Lanka: sown extent ('000 ha)



Percentage distribution of rice varietal categories in Sri Lanka 1950 – 2009



Trend in asweddamized extent, annual cultivated extent, production and average yield of rice in Sri Lanka 1950 -2010



Chemical fertilizer usage in rice cultivation

- Application of chemical fertilizer become a must for new improved high yielding rice varieties
- Chemical fertilizer applied to rice accounts for approximately 50 percent of the overall use of chemical fertilizers in Sri Lanka
- Almost all farmers use straight fertilizer in paddy cultivation
- The main fertilizers used are Urea, TSP and MOP

Importance of potassium in rice

- Increases the number of spikelets per panicle in rice and the percentage of filled grains
- Helps rice plants to overcome iron toxicity from high ferrous iron containing soils
- Improves the rigidity of pseudostems and stalks thus reducing lodging.
- Improves the quality of crop produced

Potassium fertilizer

- Muriate of Potash (MOP) is the second most dominant fertilizer used in the country.
- The annual importation is estimated to be at the level of over 95,000 mt.
- As a whole, paddy sector uses almost 36 percent of imported MOP.
- Other field crops use about 8 percent.
- Vegetable and other crops use about 37 percent

Results of potassium response studies of forty years

- Low Country Wet Zone
  - 47/54 experiments did not show a response to K.
- Mid Country Wet Zone
  - 9/11 experiments did not show a response to K.
- Low Country Dry Zone
  - 24/28 experiments did not show response to K.
- Ulpothagama, Batalagoda, Kegalle, Kandy and Maha Illuppallama
  - 31/34 long-term experiments did not show a response to K.

Published information showing soil K depletion in the rice fields of Sri Lanka is scarce.

Potassium balance under different rates of K application

K application	Total K applied	Total K uptake	K balance
per season kg ha^{-1}	kg ha^{-1}	kg ha^{-1}	kg ha^{-1}
0	0	883	-883
25	200	931	-731
50	400	932	-532
75	600	955	-355

Source: Meelu *et al.* (1995)

Response of rice to added potassium at MahaIlluppallama

K level kg ha^{-1}	Grain yield t ha^{-1}				
	Maha 89/90	Yala 90	Maha 90/91	Yala 91	Maha 91/92
0	5.4	5.6	4.6	4.6	6.4
25	5	5	4.6	5.3	6.8
50	5	6.1	4.5	5.7	7
75	5.2	5.9	4.5	5.7	6.8
100	5.2.	6	4.8	5.7	7.3
125	5.3	6	4.9	5.8	7.1
LSD (0.05)	ns	ns	ns	0.46	0.44

Kendaragama *et al*., 2007

Response of rice to application of potassium under stress conditions

	2010 yala	2010 yala	2011 yala	2011 yala
	No Water Shortage	Water Shortage	No Water Shortage	Water Shortage
NP	5.8	4.4b	4.2	3.4b
NPK	6.6	5.8ab	4.8	4.6ab
NPK + straw	6.8	6.8a	5.2	5.1a
NP + Straw	6.1	6.9a	5.2	4.5ab
	NS		NS	

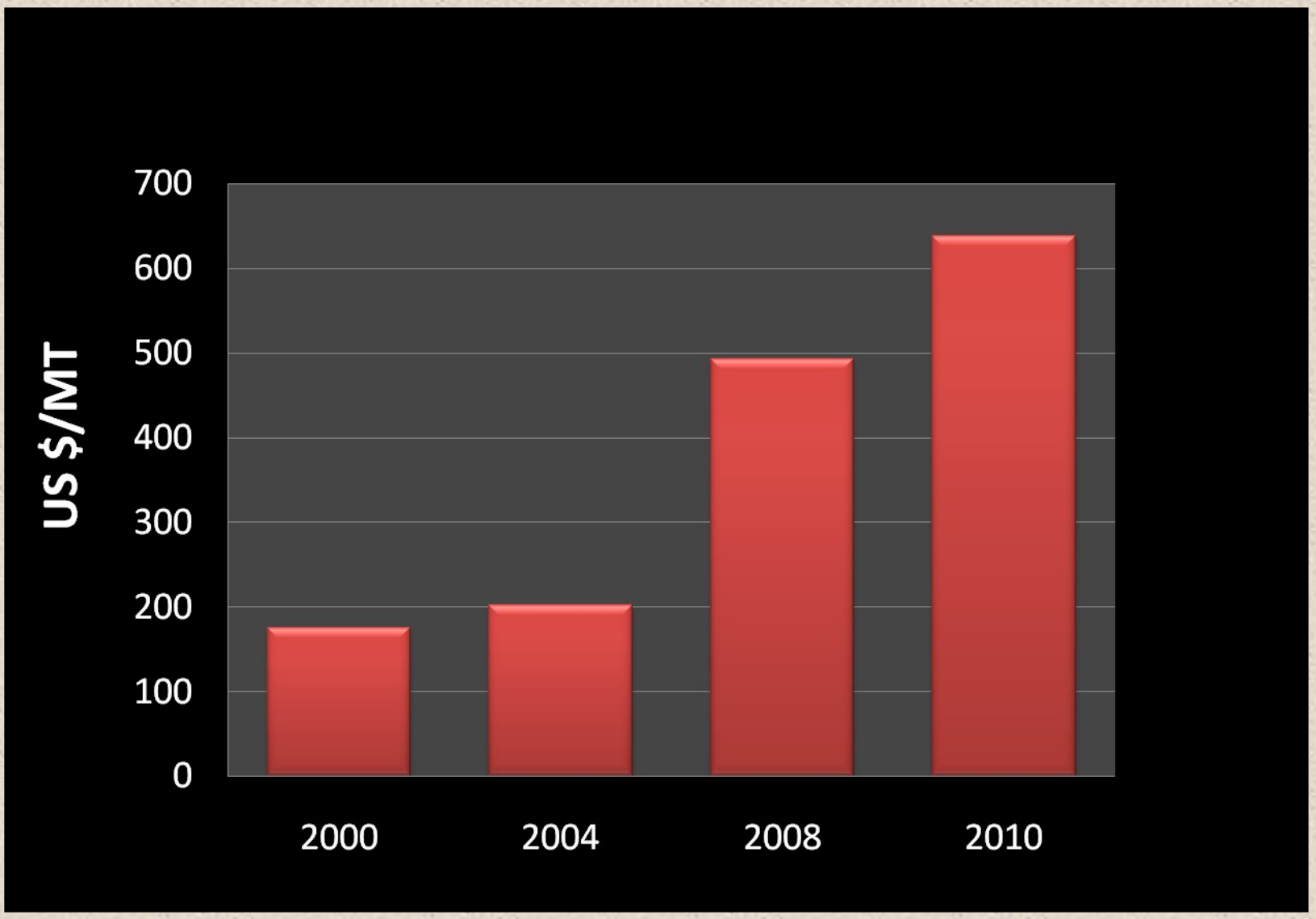
Significant response to K when there is a water shortage

Rathnayake et al., 2010

The potassium fertilizer recommendation of the Department of Agriculture for rice (2001)

Agro-climatic zone	Yield level	Potassium (K)
	(t ha^{-1})	(kg ha^{-1})
Low country, dry and intermediate zone	5	32-38
	6	38
	7	57
Up and mid country, wet and intermediate zone	4	32
	5	38
Low country wet zone (mineral soil 1*)	4	57
Low country wet zone (mineral soil 2)	4	32
*Iron toxic soils		

Potassium fertilizer prices in the world market



Judicial application of potassium

- To improve grain yield
- To enhance fertilizer use efficiency
- To maintain K reserves in Sri Lankan rice growing soils
- To save foreign exchange
  - Sri Lanka does not have potash ores and potash fertilizer is imported
  - Large sum of foreign exchange is spent on K fertilizer
- To reduce burden to government revenue
  - K fertilizer is given on subsidized price
  - Muriate of potash which costs about Rs. 72.00 per kg is made available to the farmer at Rs. 7.00

K fertilizer Sources

- Fertilizers which release plant nutrient slowly
  - Nutrients are available to plant when plant need it
  - Nutrient losses are very low
  - Required quantities are very low
  - Increase fertilizer use efficiency
- Need to import less quantity of fertilizer
- Application is needed only once
  - Labour savings for fertilizer application

Nano K-fertilizer has all these qualities

Information available under local condition at present is not enough to convince farmers on the effect of nano K-fertilizer on grain yield

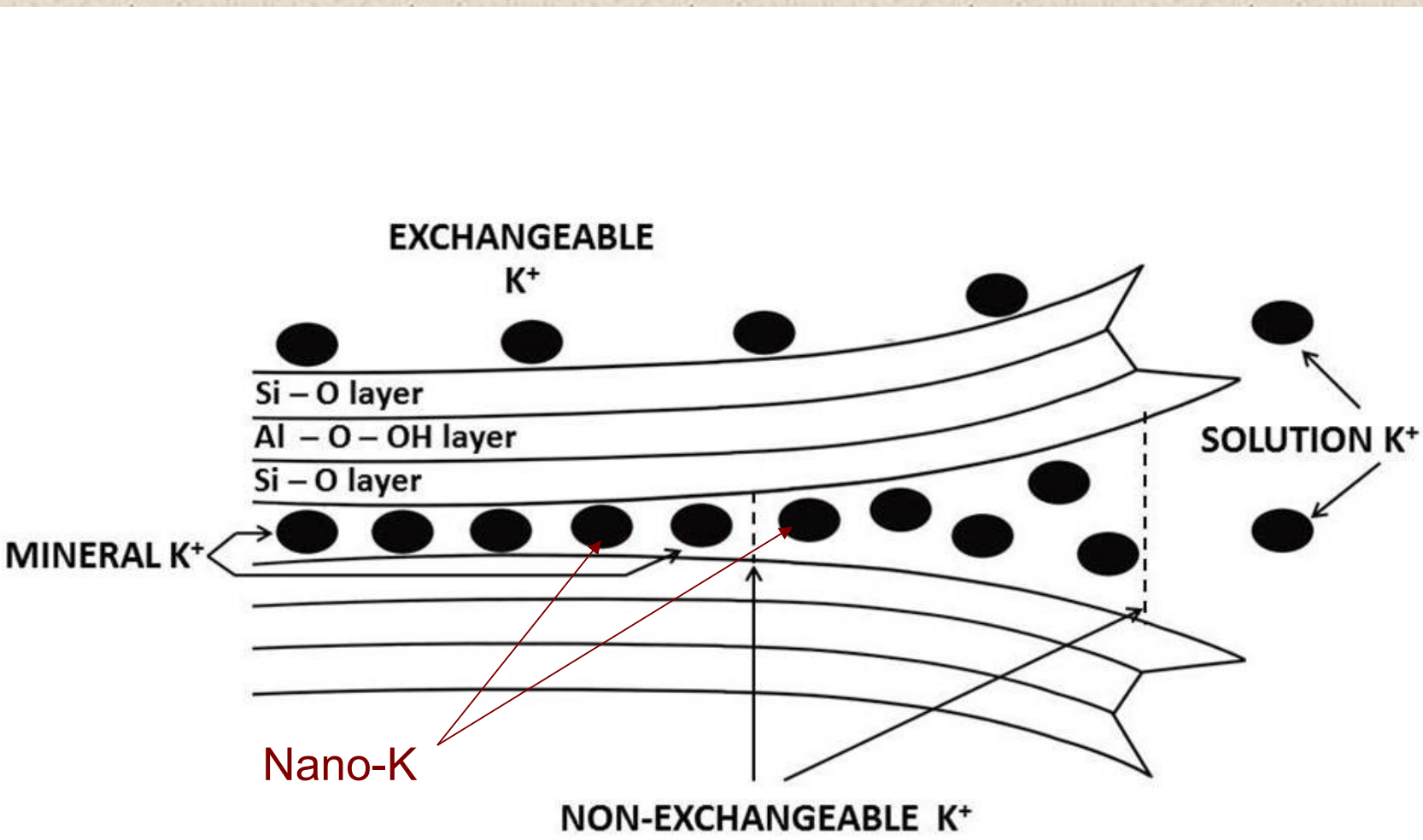
Objective

To determine the effects of nano-K fertilizer on rice yield in irrigated rice

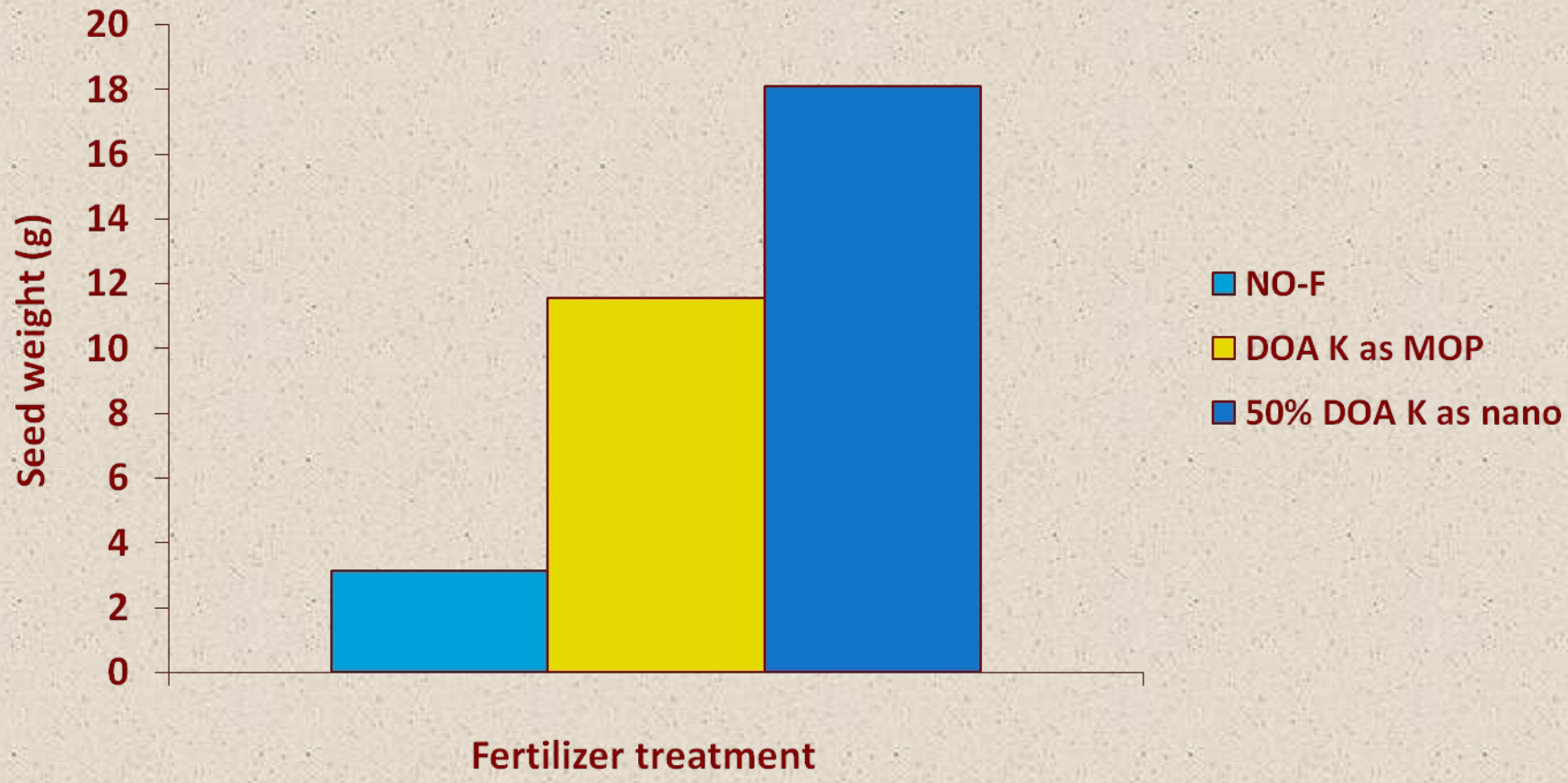
Nano-K fertilizer

Nano-K fertilizer

Form of potassium in the nano-K material



Results of the pot experiment
Total seed weight (g/pot)



Field experiment

- Location:

  Rice Research and Development Institute, Batalagoda,

  Low Country Intermediate zone

- Soil group

  Poorly drained Red Yellow Podzolic soil

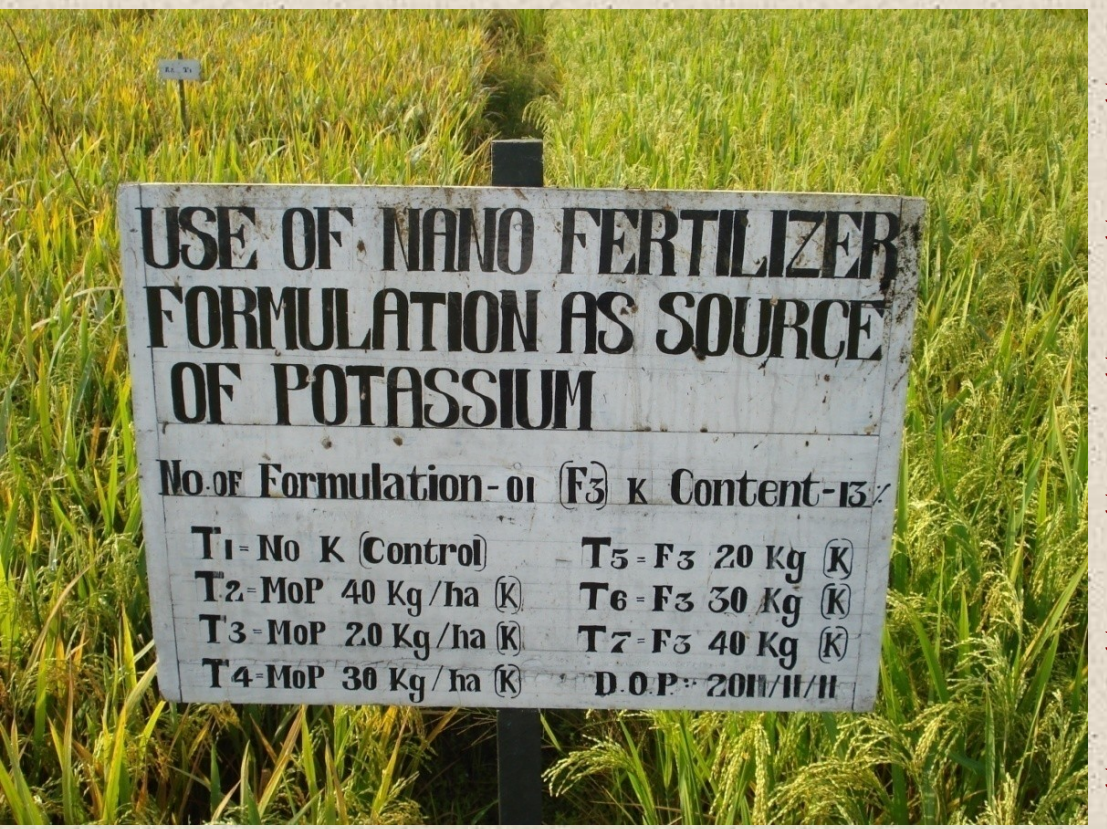
  belongs to Kurunegala soil series

.....Field experiment

- Test variety: Bg 366
- Crop establishment:

  Transplanting
- Cultural practices:
  - Recommended for pest, diseases and weed control were adopted
  - Cultivation was done with supplementary irrigation
- Long-term experiment

Treatments



- T1 - 0 Kg k_2O ha^{-1}
- T2 - 20 kg k_2O ha^{-1} as MOP
- T3 - 30 kg k_2O ha^{-1} as MOP
- T4 - 40 kg k_2O ha^{-1} as MOP
- T5 - 20 kg k_2O ha^{-1} as Nano –K
- T6 - 30 kg k_2O ha^{-1} as Nano –K
- T7 - 40 kg k_2O ha^{-1} as Nano –K

Nano-K formulation: 13% K_2O

Carrier material was montmorilonite clay

Treatment application

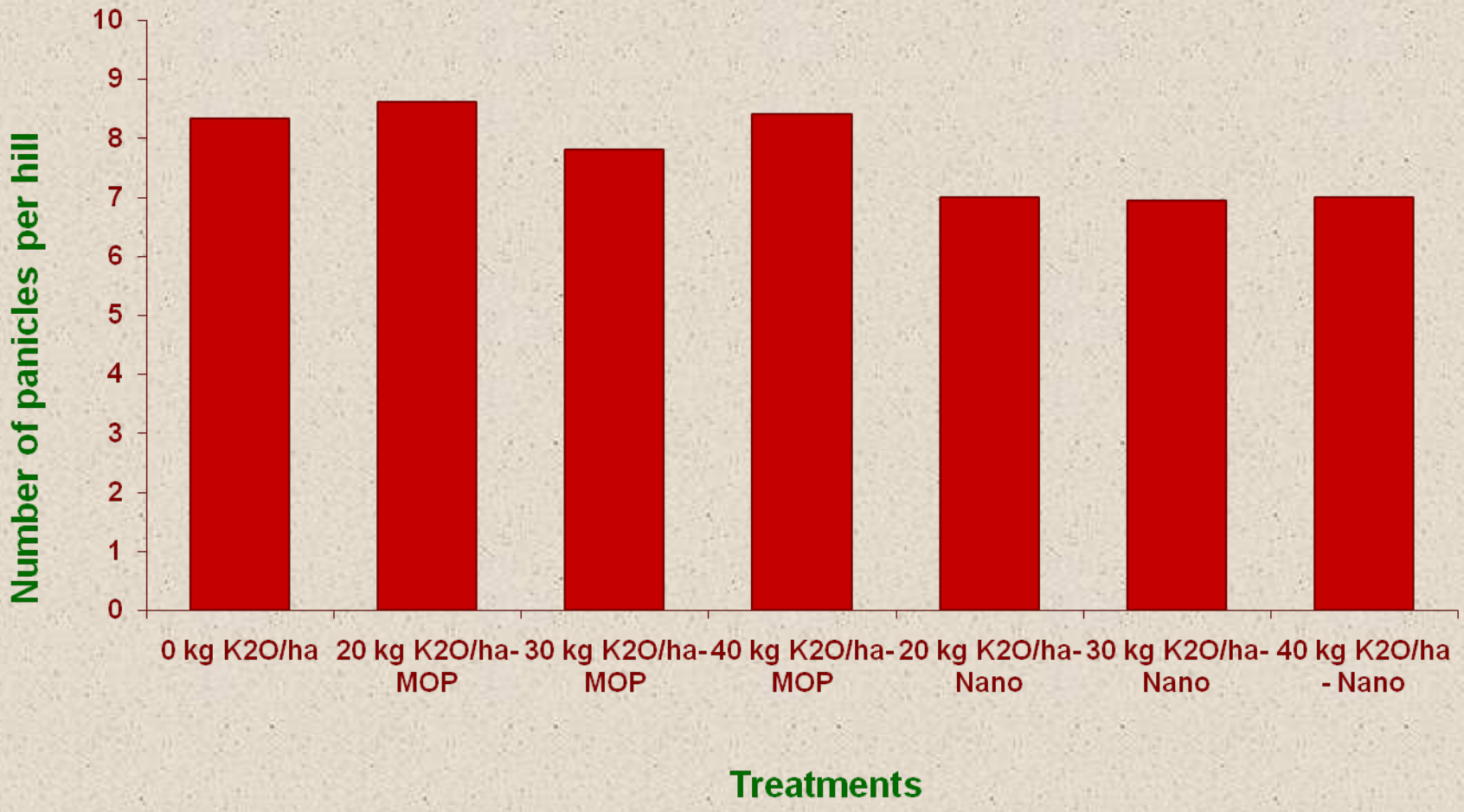
- Nitrogen (kg ha^{-1})
  - 5 N at planting
  - 25 N at 2 weeks after planting
  - 55 N at 4 weeks after planting
  - 20 N at 6 weeks after plating
- Phosphorous: (kg ha^{-1})
  - 45 P_2O_5 at planting
- Potassium: MOP
  - 50% K at planting
  - 50% K at Panicle initiation
- Potassium: Nano
  - 100 % K at planting

Observations and measurements

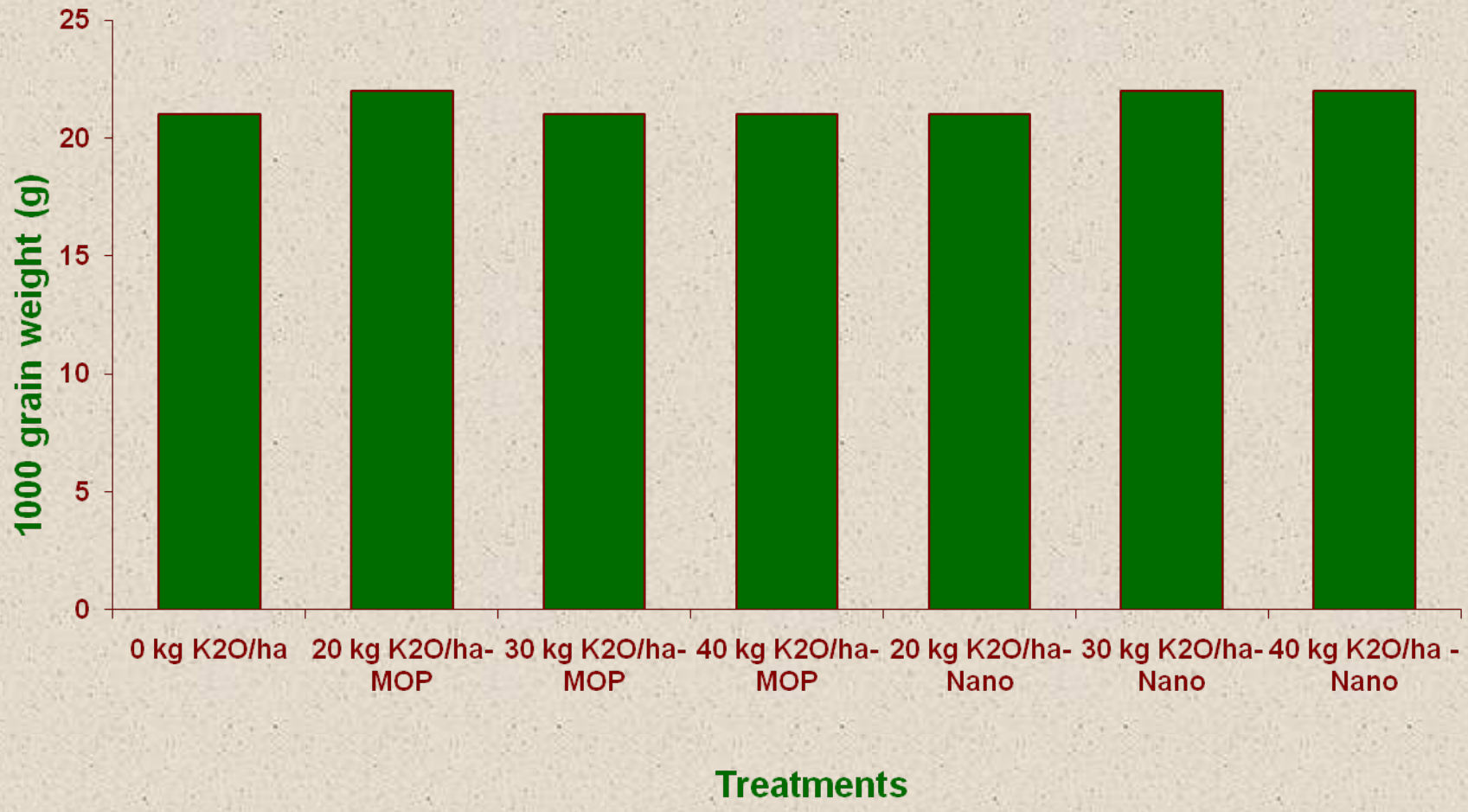
- Number of panicles per m^2
- Number of seeds per panicle
- Percentage filled grains
- 1000 grain weight
- Grain yield (at 14% moisture content)

Results of the 1st Season

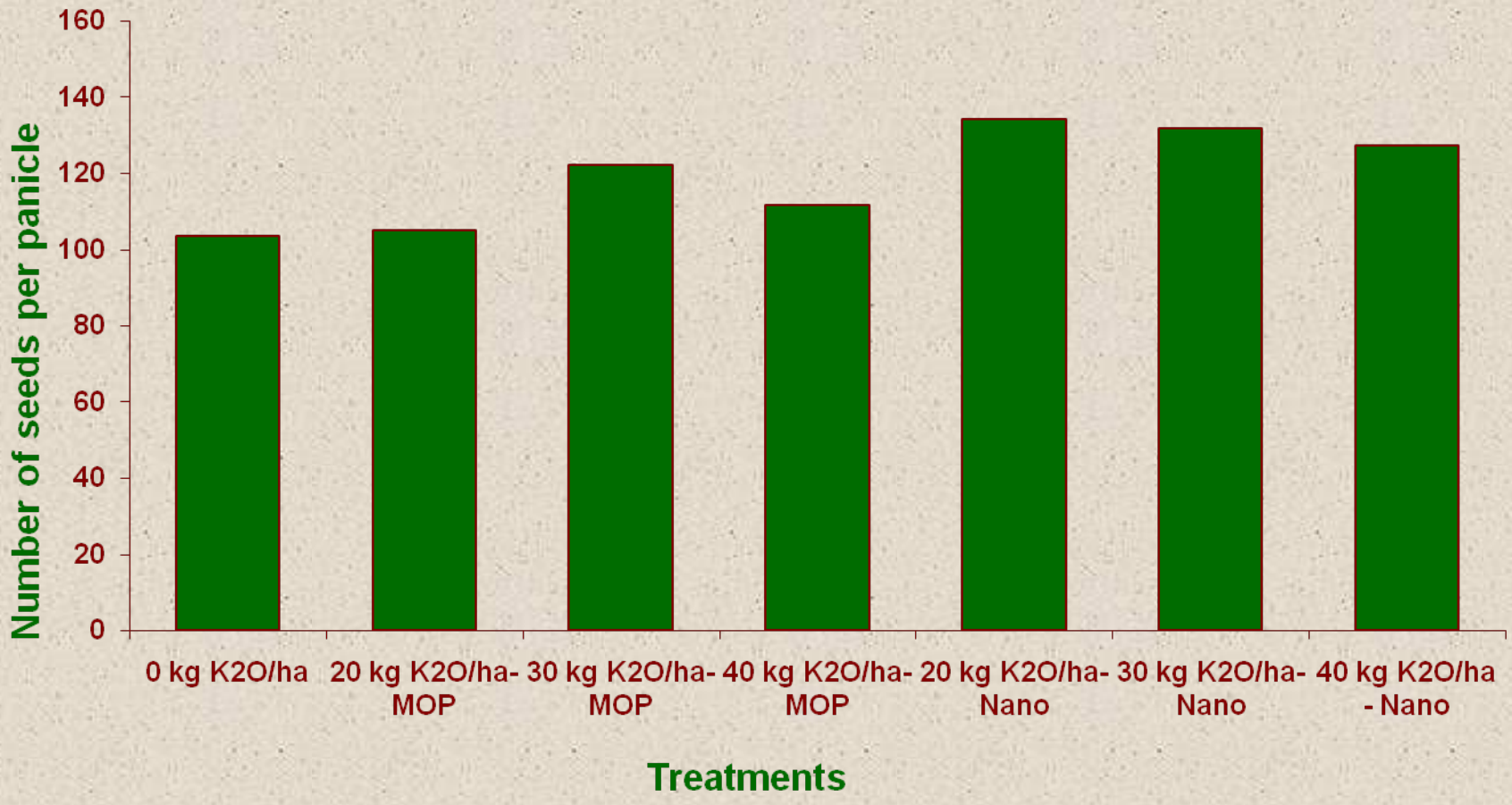
Effect of nano - K on number of panicles per hill



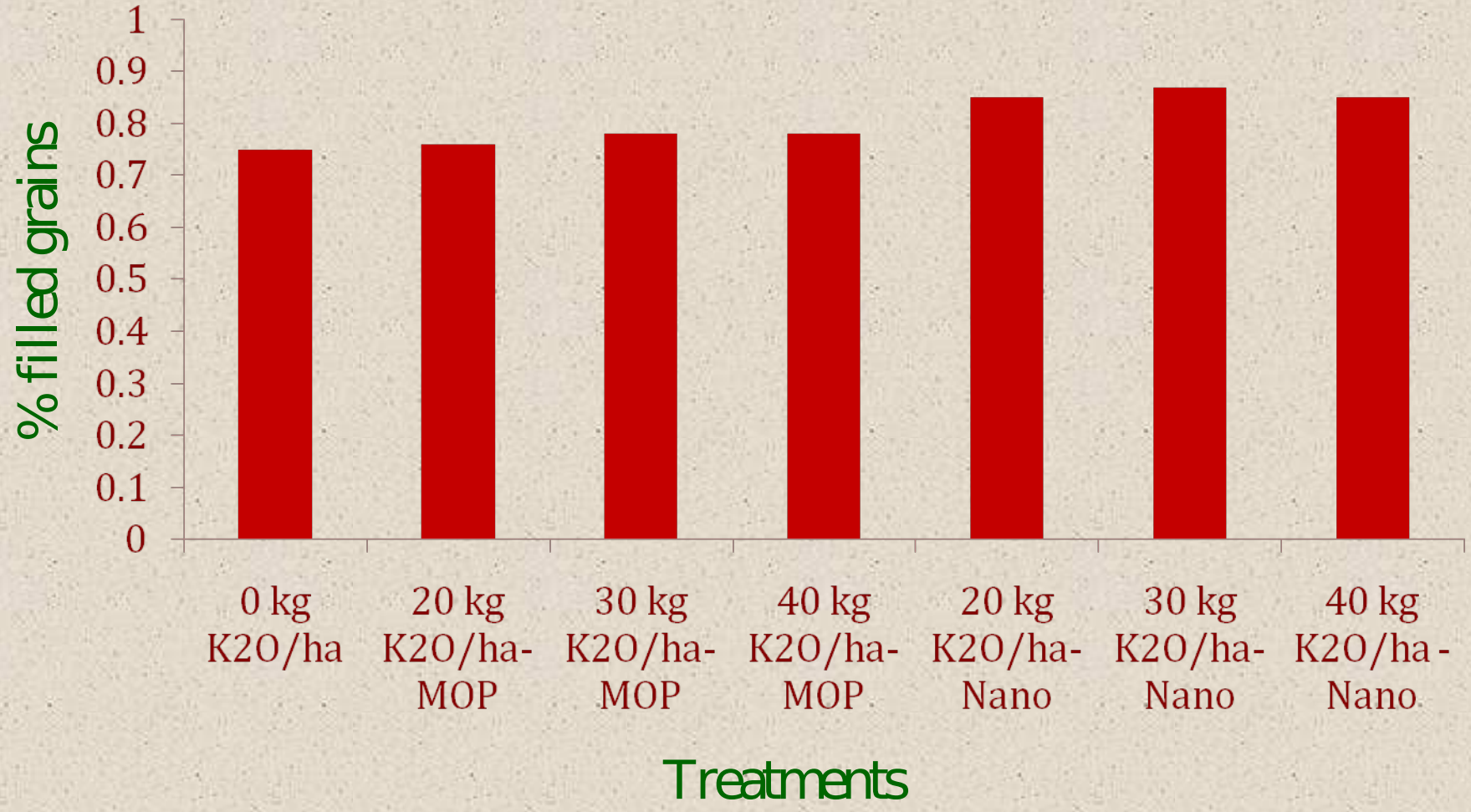
Effect of nano-K on 1000 grain weight



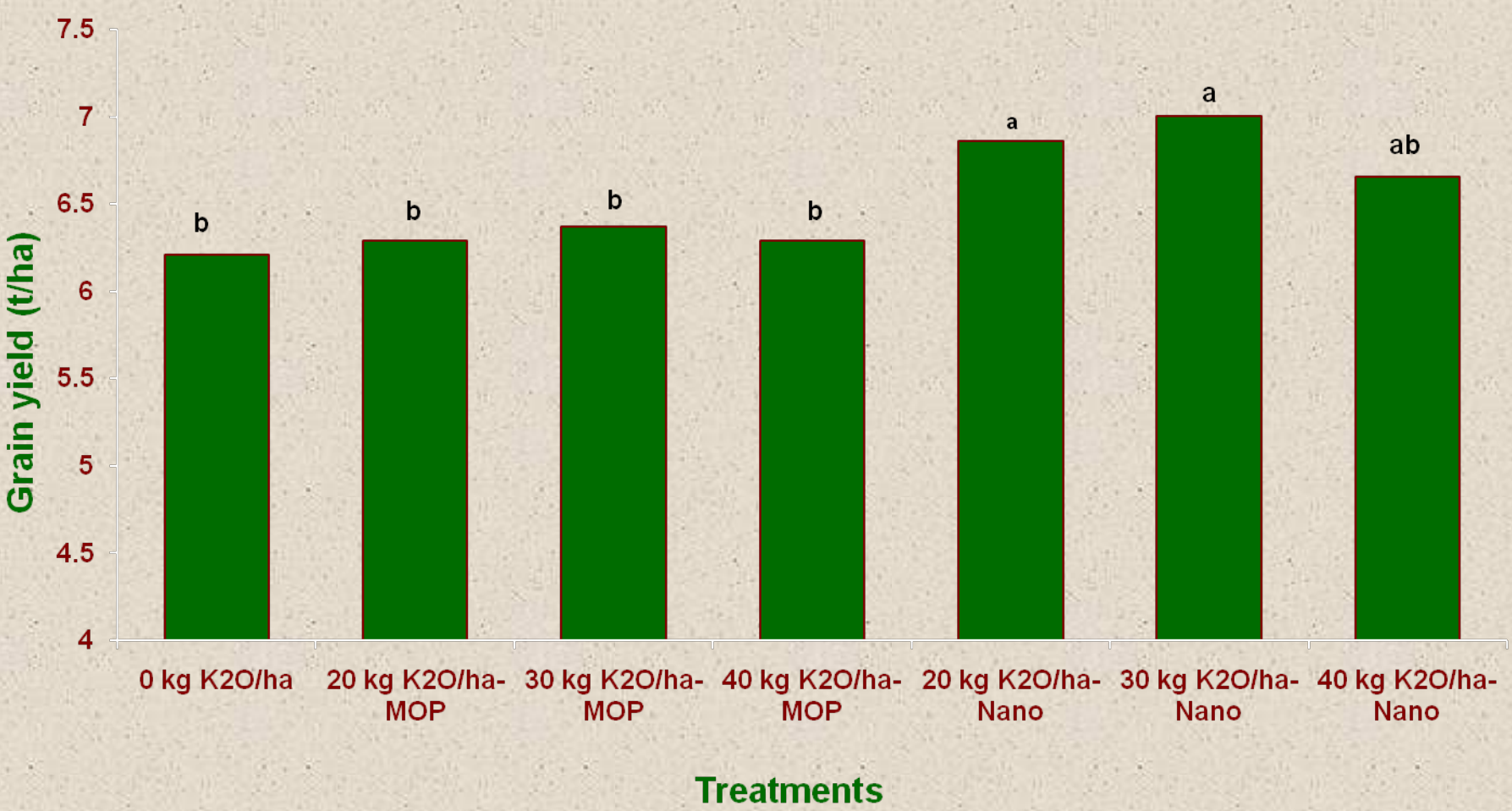
Effect of nano- K on number of grains per panicle



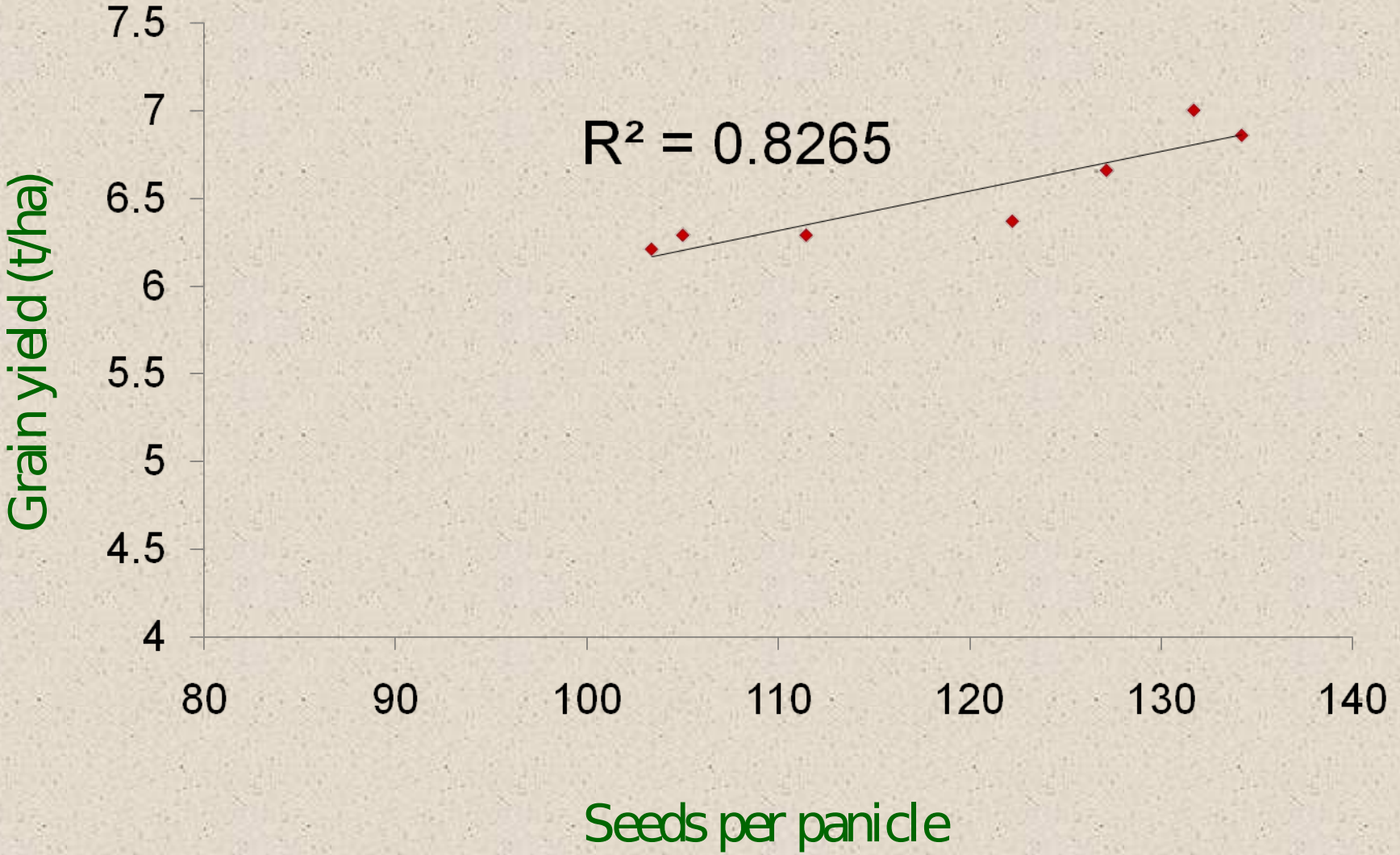
Effect of nano- K on percentage filled grains



Effect of nano-K on grain yield



Relationship between number of grains per panicle and grain yield in K fertilizer experiment



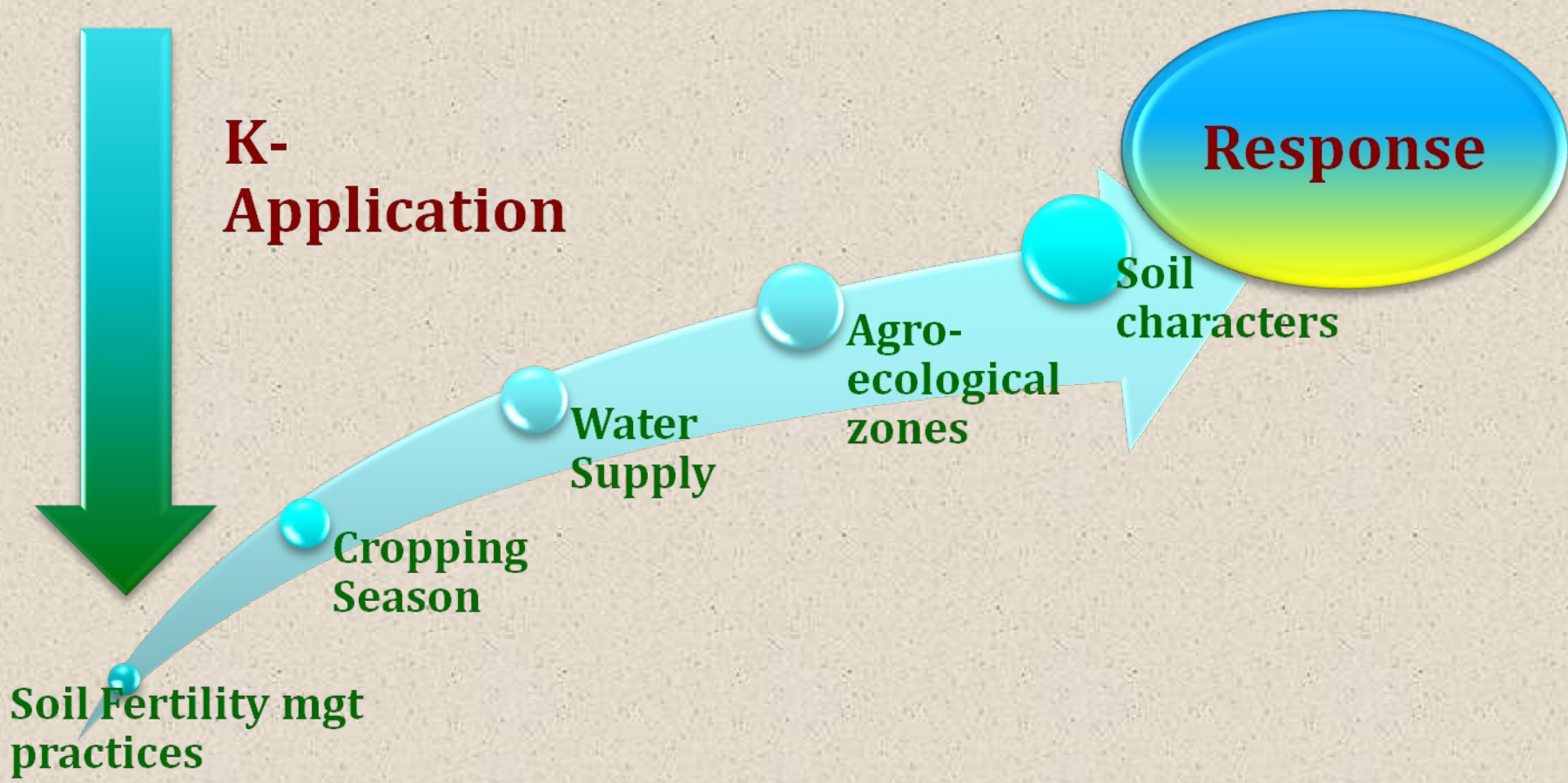
Highlights

- Nano- K fertilizer is a better source of K for rice
- Nano- K fertilizer improves
  - number of grains per panicle
  - percentage filled grains
- Nano- K fertilizer increase grain yield
  - Yield increase is 10% over MOP
- Required quantity is less than MOP

- These finding reveals the advantage of application of nano-K fertilizer in rice fields

- Profitability of rice cultivation depends on the price of the nano- K fertilizer

Response of rice to K fertilizer



Before recommending nano- K fertilizer to paddy fields

Effect of nano-K fertilizer on rice should be tested in

longer term trials

different soils groups

different management conditions

different agro-ecological conditions


This is a beginning
more information will be available in the future
THANK YOU